INFORMATION SCIENCE TEAM

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INFORMATION EXTRACTION AND DATA HANDLING

OBJECTIVES

- HELP IDENTIFY BOUNDS OF PRACTICAL MISSIONS
- IDENTIFY DATA HANDLING AND ANALYSIS SCENARIOS
- IDENTIFY AND SUPPLY THE REQUIRED ENABLING TECHNOLOGY
- IDENTIFY AND SUPPLY THE DESIGN DATA BASE FOR PARAMETER SELECTION

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Areas of Concern

- Data handling aspects of system design
- Enabling technology for data handling
- Enabling technology for analysis

INFORMATION EXTRACTION AND DATA HANDLING

Information Extraction Milieu - Potential Modes

- Support to individual P.I. research
- Organized support to research tasks
- Design of systematic research program data system
- Support to research data system operation

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Common Themes - Analysis

- Analysis of atmosphere problems needs solution
- Effects of better resolution (spatial, spectral) promising but unproven
- Registration problems will be worse with smaller pixels
- Off-nadir viewing promising, but will add new problems
- Geographic information system development needed to allow analysis tasks to concentrate on analysis

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COMMON THEMES - DATA HANDLING

- PARAMETER SELECTION FOR RESEARCH SYSTEM NEEDS DATA BASE
- RESEARCH SCENARIOS WILL BE DIFFERENT THAN OPERATIONAL SCENARIOS
- RESEARCH PROGRAM WILL COLLECT LARGE AMOUNTS OF DATA - DATA HANDLING MUST BE EFFICIENT
- VLSI AND OTHER NEW TECHNOLOGIES MUST BE ADAPTED TO REMOTE SENSING RESEARCH NEEDS

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System Design

Status

- Present system (Landsat) is survey-mode with centralized processing and archive
- Data delivery is manual (tape), slow
- Minimal special processing available
- Little data other than from MSS available

Contributing Factors

- System is experimental but operational use is attempted
- Open skies implies more data processing than otherwise needed
- Data analysis has concentrated on Landsat data

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System Design

Critical Issues

- Increasing data rates will make future system design more critical
- Production efficiencies must be evaluated even in an experimental system
- No design data base for future mission design
- Data form causes user problems, particularly in registration

Recommendations For Investigation

- Alternate system architectures need study
- Provide data base for design of future missions
- Include user information extraction models in system design
- Provide data in optimum form

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Data Handling Technology

Status

- Decreasing memory costs allow more computer memory and the related increased processing capability
- Microprocessor capabilities increasing rapidly
- New storage medium (digital video disks) imminent
- Very large scale integrated circuit (VLSI) technology improving, but no developments particularly for remote sensing

Contributing Factors

- Sales volume for remote sensing not sufficient to drive the technology

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DATA HANDLING TECHNOLOGY

CRITICAL ISSUES

- INCREASING DATA RATES WILL OVERLOAD PRESENT-TECHNOLOGY SYSTEMS
- PRESENT SYSTEM DESIGN, BASED ON MAG TAPE, HINDERS RANDOM ACCESS
- SYSTEMS FOR HANDLING GEOGRAPHIC DATA IN INFANCY

RECOMMENDATIONS FOR INVESTIGATION

- NEW TECHNOLOGIES ALLOW NEW SYSTEM CONFIGURATIONS - DESIGN STUDIES NEEDED:
  - CENTRALIZED VS. DISTRIBUTED PROCESSING
  - ON-BOARD VS. GROUND PROCESSING
  - DATA COMPRESSION
  - VIDEO DISK TECHNOLOGY
  - VLSI
- SPONSOR THE DEVELOPMENT OF COMPREHENSIVE GEOGRAPHIC INFORMATION SYSTEMS

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RECTIFICATION AND REGISTRATION

STATUS

- RECTIFICATION IS REQUIRED ON EVERY IMAGE
- REGISTRATION ACCURACY GENERALLY 0.5 TO 1.5 PIXELS
- PAUCITY OF WORLDWIDE MAPS PROHIBITS GEODETIC IMAGE LOCATION
- INTERPOLATION EFFECTS STILL NOT GENERALLY UNDERSTOOD/ACCEPTED
- LARGE AREA MOSAICKING IS TEDIOUS

CONTRIBUTING FACTORS

- EPHEMERIS AND ATTITUDE KNOWLEDGE IS INSUFFICIENT FOR GEODETIC LOCATION WITHOUT GROUND CONTROL
- GROUND CONTROL OFTEN NOT AVAILABLE, EVEN WITH MAPS
- INTRAIMAGE DISTORTIONS (E.G., LANDSAT-D) PARTICULARLY TROUBLESOME
- INTERPOLATION VARIABLY AFFECTS ANALYSIS

INFORMATION EXTRACTION AND DATA HANDLING

RECTIFICATION AND REGISTRATION

CRITICAL ISSUES

- INTRAIMAGE DISTORTIONS IN SENSOR MUST BE AVOIDED
- EPHEMERIS AND ATTITUDE KNOWLEDGE NEED IMPROVING
- CONTROL POINT CORRELATION NEEDS FURTHER STUDY
- REGISTRATION OF OFF-NADIR IMAGES WILL BE DIFFICULT
- FOR THE RELATED AIRCRAFT DATA, ATTITUDE KNOWLEDGE AND REGISTRATION ARE SEVERE PROBLEMS

RECOMMENDATIONS FOR INVESTIGATION

- DETERMINE HOW BEST TO USE CONTROL POINTS
- DETERMINE HOW TO VERIFY GEOMETRIC PERFORMANCE
- DETERMINE EFFECTS OF (VARIOUS) DATA COMPRESSION TECHNIQUES ON REGISTRATION
- FURTHER STUDY THE EFFECTS OF INTERPOLATION

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Information Extraction Analysis

Status

- Low-dimensionality analysis maturing (spectral and spatial)
- High-dimensionality analysis primitive (spectral and spatial)
- Temporal analysis is ad hoc; agriculture phenologic stage analysis is maturing

Contributing Factors

- Registration and data handling problems have hindered analysis efforts, particulary with multiresolution data
- Sensor and data characterizations have been incomplete
- Generalized modeling techniques are inadequate
- Equipment diversity hinders interchanges

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INFORMATION EXTRACTION - ANALYSIS

CRITICAL ISSUES

- UTILITY OF ABSOLUTE RADIOMETRICALLY CALIBRATED DATA IS UNKNOWN
- UTILITY OF GREATER RADIOMETRIC RESOLUTION IS UNKNOWN
- UTILITY OF HIGHER SPATIAL RESOLUTION EXCITING BUT UNPROVEN
- UTILITY OF MORE SPECTRAL BANDS EXCITING BUT UNPROVEN
- HIGH-DIMENSIONALITY ANALYSIS PROMISING BUT DIFFICULT

RECOMMENDATIONS FOR INVESTIGATION

- CONDUCT EXPERIMENTS WITH PARAMETERS EXCEEDING EXPECTED MISSION PARAMETERS TO DETERMINE UTILITY THRESHOLDS
- PROVIDE METHODS FOR CROSS-DISCIPLINE FERTILIZATION
- DETERMINE BETTER WAYS OF CONVERTING ANALYSIS CONCEPTS TO SOFTWARE
- INVESTIGATE AND CHARACTERIZE TOTAL SYSTEM INCLUDING ATMOSPHERE
- INVESTIGATE THE USE OF HIGHER-DIMENSION ANALYSIS SUCH AS TEXTURE

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INFORMATION EXTRACTION - ENABLING TECHNOLOGY

STATUS

- GEOMETRIC OPERATIONS AND MULTISPECTRAL CLASSIFICATION (ESPECIALLY) REQUIRE EXCESSIVE AMOUNTS OF COMPUTER TIME
- LARGE SYSTEM OPERATION IS EXPENSIVE; SMALL SYSTEMS ARE LIMITED
- SEVERAL MODERATE SIZE SYSTEMS ARE AVAILABLE, BASED ON GENERAL PURPOSE COMPUTERS
- GEOGRAPHIC INFORMATION SYSTEMS ARE USED BUT ARE SPECIALIZED, INFLEXIBLE, AND DIVERSE

CONTRIBUTING FACTORS

- REMOTE SENSING REQUIREMENTS NOT EXTENSIVE ENOUGH TO CAUSE SPECIALIZED TECHNOLOGY DEVELOPMENTS
- SOFTWARE DEVELOPMENT HAS NOT BEEN SPONSORED TO THE POINT WHICH WOULD COALESCE THE VARIOUS AD HOC SYSTEMS
- LACK OF DATA COMMONALITY STANDARDS HINDERS THE USE OF GEOGRAPHIC DATA

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INFORMATION EXTRACTION - ENABLING TECHNOLOGY

CRITICAL ISSUES

- GEOGRAPHICAL PROCESSING ALGORITHMS AND THE EVER-INCREASING DATA SET SIZE ARE OUTSTRIPPING GENERAL PURPOSE COMPUTER CAPABILITIES
- LACK OF SOFTWARE AND DATA INTERCHANGE STANDARDS HINDER CROSS-FERTILIZATION

RECOMMENDATIONS FOR INVESTIGATION

- INVESTIGATE THE POSSIBLE ANALYSIS SOFTWARE MODIFICATIONS TO ALLOW THE USE OF VLSI
- INVESTIGATE POTENTIAL NEW COMPUTER ARCHITECTURES SUITABLE FOR GEOGRAPHIC (SPATIAL) PROBLEMS
- PROMOTE THE DEVELOPMENT OF MODULAR HARDWARE AND SOFTWARE TO ALLOW WIDER TECHNOLOGY INTERCHANGE
- INVESTIGATE/DEVELOP NETWORKING SYSTEMS TO ALLOW NON-LOCAL PROCESSING

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Potential Support Mode - Support to Individual P.I.

- Encourage PI data commonality
- Assist PI data interchange
- Sponsor cross-discipline research

  E.g., Atmosphere studies
  Object size distributions
  Interpolation
  Registration
  Off-nadir viewing

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POTENTIAL SUPPORT MODE - ORGANIZED SUPPORT TO RESEARCH TASKS

- PROVIDE CROSS DISCIPLINE DATA SOURCES (E.G., AIRCRAFT, SHUTTLE, ... INSTRUMENTS AND FLIGHT SUPPORT)
- PROVIDE COORDINATED DATA SETS VIA GEOGRAPHIC INFROMATION SYSTEMS
- FACILITATE CROSS DISCIPLINE DATA DISTRIBUTION
- DEVELOP VLSI FOR EFFICIENT DATA HANDLING
- SPONSOR CROSS DISCIPLINE RESEARCH (AS ABOVE)

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POTENTIAL SUPPORT MODE - SYSTEMATIC DATA SYSTEM DESIGN

- GATHER THE DECISION DATA BASE TO ENABLE PARAMETER TRADEOFFS
- PERFORM TRADEOFF STUDIES SUCH AS:
  - ON BOARD VS. GROUND PROCESSING
  - DATA COMPRESSION TECHNIQUES
  - OPTIMUM BIT ALLOCATION (SPATIAL VS. SPECTRAL VS. QUANTIZATION)
  - SYSTEM MODE
- SPONSOR CROSS-DISCIPLINE RESEARCH
- DEVELOP ARCHIVAL/RETRIEVAL TECHNIQUES
- DEVELOP GIS, FORMATTING AND LABELING TECHNIQUES
- DEVELOP VLSI AND NEW SYSTEM ARCHITECTURE AS REQUIRED
- DEVELOP OTHER SYSTEM-ENABLING TECHNOLOGIES SUCH AS VIDEO DISKS
- DEVELOP TECHNIQUES FOR PROVIDING MULTITYPE DATA SETS

INFORMATION EXTRACTION AND DATA HANDLING

POTENTIAL SUPPORT MODE - SUPPORT TO SYSTEM OPERATION

- PROVIDE (AN) EFFICIENT ARCHIVAL/CATALOG/RETRIEVAL SYSTEM(S)
- PROVIDE EFFICIENT GIS, LABELING AND FORMATTING GUIDELINES
- IMPLEMENT NEW SYSTEM DESIGNS, WITH VLSI AS APPLICABLE
- PROVIDE SYSTEM CHARACTERIZATION